Exposure assessment for epidemiological studies in livestock: Measurement campaigns and simulations

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***Abstract*— Due to the extensive placement of mobile phone base stations on farms, there is a need to investigate potential impact of high-frequency electromagnetic fields on livestock health and production. The goal of this pilot study was to compare different measurement protocols in the field with the aim to develop an approach that would allow epidemiological investigations. Our results demonstrate that simulation models allow for a first rough assessment of the exposure situation on a farm. On farms that are close to a base station, have many trees or lie in hilly areas, additional measurements are indicated. The results also demonstrated that it is possible to classify farms into exposure categories that differ by >10 dB, but a relatively large number of farms needs to be tested.**

I. Introduction

Due to the wide-spread and increased installation of transmitters for mobile communication, broadcast and other services, the electromagnetic environment has changed considerably. As transmitters are often installed in agricultural areas, farmers question if the radiated high-frequency electromagnetic fields may influence health and performance of farm animals kept nearby transmitters. A survey conducted in 2002 by the Swiss Federal Veterinary Office yielded an increasing sensitisation of animal keepers.

The aim of this feasibility study was to investigate, how exposure from electromagnetic fields on dairy farms can be assessed with acceptable time and effort. A possible association between performance of dairy cows and exposure was not assessed as part of this study.

II. methods

In a first step, the distribution of immission was simulated for a number of selected farms by means of a suitable software (NISView), using the actual operating parameters as reported by the Swiss Federal Office of Communications (OFCOM). Based on these simulations, spot measurements were carried out on pasture, in exercise yards and stables on 13 farms in the Canton Baselland from April to June 2006. Simultaneously, one 24-hrs-measurement was conducted on each farm. Measurements were performed with two frequency-selective systems of the type SRM-3000 (Narda STS, Hauppage NY, USA). For exposure assessment, the time-weighted average was calculated for stable, yard and pasture, which was used to calculate the daily exposure for summer and winter conditions as well as the exposure per year. Only measurement values at least 3 dB above the measured noise level in the related frequency band were included in the calculations. Farms were categorised according to their exposure. Categories were accepted when - after inclusion of a measurement error of 45 per cent - the difference between two farms was at least 10 dB. Furthermore, the daily exposure variation due to traffic variation of the mobile base stations was analysed, as well as the consistency of simulated and measured values and the calculated daily exposure with and without inclusion of the 24-hrs-measurement.

III. Selected results

The daily exposure for winter days without using an exercise yard ranged from 0.0324 to 0.1396 V/m. With access to an exercise yard the daily exposure was 0.0033 to 0.2028 V/m. Under summer conditions with access to pasture, the daily exposure ranged from 0.0258 to 0.3060 V/m. The weighted exposure per year ranged from 0.0196 to 0.2610 V/m. A categorisation of farms was feasible (Figure 1), but a larger sample size should be included, since a considerable amount of farms could not be allocated to either the exposed or non-exposed group because the exposure difference was < 10 dB.

The daily exposure variation from traffic load of mobile transmitters was mainly in the range of the measurement error. Deviations between calculated and measured values were mainly due to shadowing effects from hills and trees as well as inaccurate data for the elevation differences close to transmitters (Figure 2).

The calculation of daily exposure with and without inclusion of 24-hrs-measurement showed a good consistency of the two methods (Figure 3).

IV. Conclusions

Using a high quality simulation program, the combination of simulation and spot measurements allowed reducing measurement efforts to a degree which allows assessing a larger sample within appropriate time. In hilly and tree-covered areas, as well on pasture close to base station with GSM 1800 and on farms near settlements with several transmitters, control measurements may be required. For this

purpose, spot measurements are sufficient when – due to little mobile traffic or dominant constant broadcast signals – little daily variation can be expected. The weighted daily exposure was found to be independent of the distance to the next transmitter. Therefore, the criterion “distance” should not be used for the selection of exposed and non-exposed farms in further studies.

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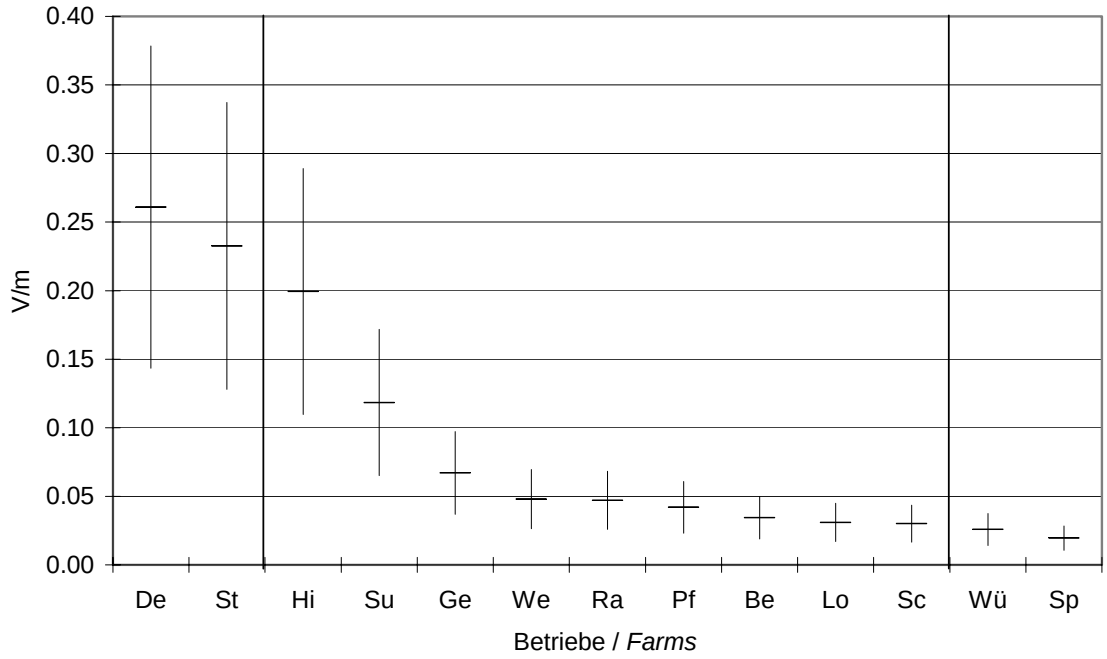

Figure 1: The 13 farms in order of decreasing exposure per year. Categories were accepted as significantly different, if the difference was at least 10 dB after consideration of a measurement error of 45% (two farms each on the left and right side of the graph).

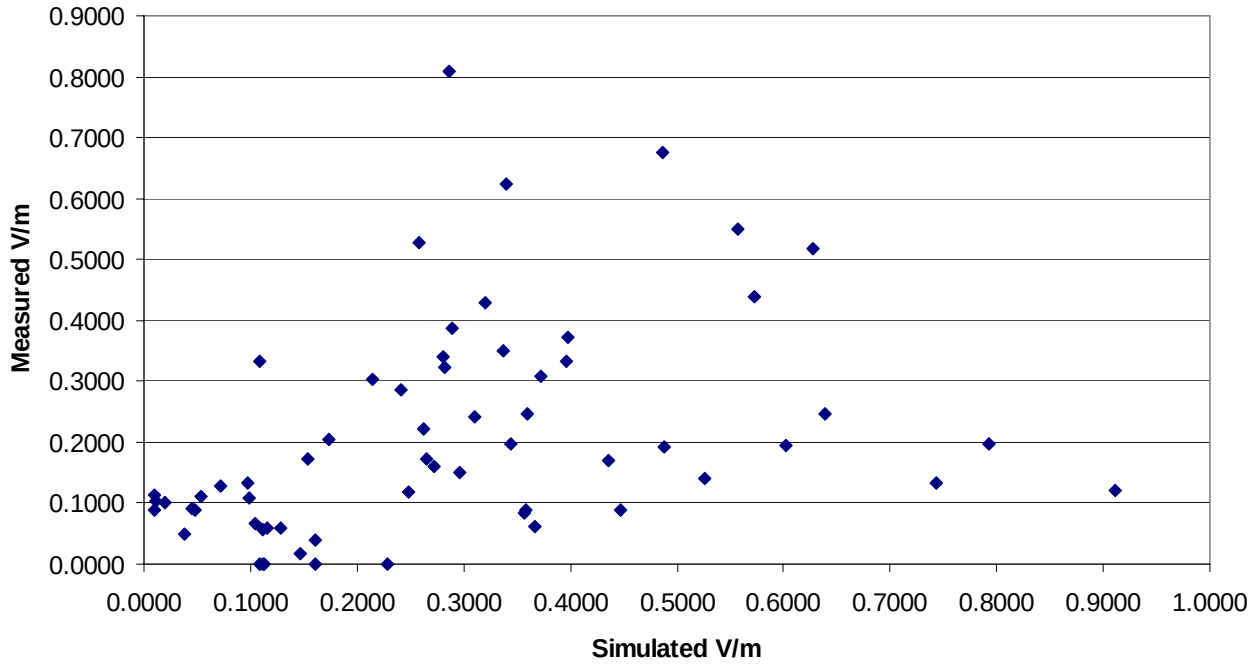

Figure 2: Comparison of measured and simulated (NISView) spot exposure values (correlation coefficient = 0.37). Large values show that an exclusively simulated calculation of exposure can be awkward on tree-covered positions with several transmitters and busy mobile transmitters

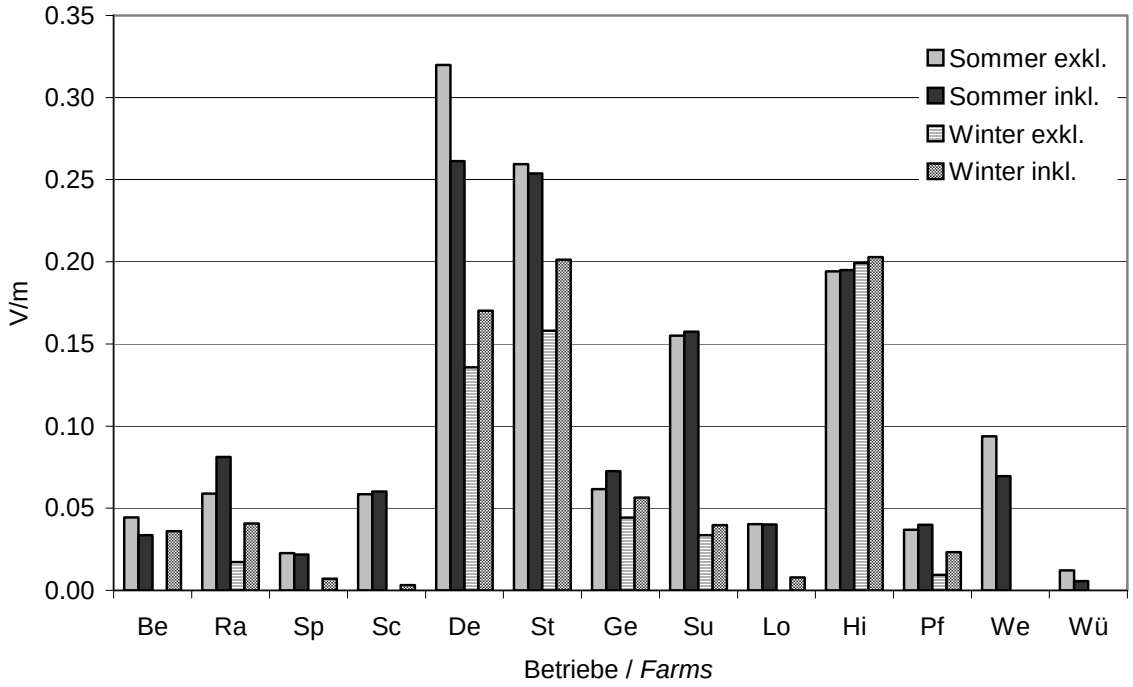

Figure 3: Comparison of daily exposure with (incl.) and without (excl). inclusion of the 24-hrs-measurement. The mainly small differences can be explained by the small daily variations in traffic load of the mobile transmitters